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Original Articles

Changes in body composition of elite Kyrgyz national athletes over 6-month training period

Mudanças na composição corporal dos atletas de elite do Kırgızistan em seis meses de treinamento

Cambios en la composición corporal de los atletas de élite de Kirguistán en un período de entrenamiento de seis meses

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Keywords:
National athletes; Body composition; Differences; Kyrgyzstan.

ABSTRACT
This study was conducted to determine changes in the body composition of elite National Team athletes during a training period. A total of 35 male National Team athletes selected by the Olympic Committee of Kyrgyzstan (9 Greco-Roman wrestlers, 10 freestyle wrestlers, 8 judo athletes, and 8 athletics athletes) were included in the study. Athletes' body weight, body mass index (BMI), body fat percentage (BFP), diameter, and circumference measurements were assessed twice: at the beginning of the season and six months later. The results showed that even elite athletes experience changes in their body composition during periods of intensive training in preparation for high-level competitions.

Palavras-chave:
Atletas nacionais; Composição corporal; Diferenças; Quirguistão.

RESUMO
Este estudo tem como objetivo identificar as mudanças na composição corporal dos atletas de elite da Equipe Nacional durante o período de treinamento. O estudo incluiu 35 atletas masculinos recomendados pelo Comitê Olímpico do Quirguistão (9 lutadores de estilo greco-romano, 10 lutadores de estilo livre, 8 judocas e 8 atletas de atletismo). O peso corporal, o índice de massa corporal (IMC), o percentual de gordura corporal (PGC), bem como os diâmetros e circunferências dos atletas, foram medidos em dois momentos: no início da temporada e seis meses depois. Como resultado, constatou-se que até mesmo atletas de elite apresentam mudanças em sua composição corporal durante períodos de treinamento intenso para competições de alto nível.

Palabras clave:
Atletas nacionales; Composición corporal; Diferencias; Kirguistán.

RESUMEN
Este estudio tiene como objetivo identificar los cambios en la composición corporal de los atletas de élite del equipo nacional durante el período de entrenamiento. En el estudio participaron 35 atletas masculinos, recomendados por el Comité Olímpico de Kirguistán (9 luchadores de estilo grecorromano, 10 luchadores de estilo libre, 8 judokas y 8 atletas de atletismo). Se midieron dos veces el peso corporal, el índice de masa corporal (IMC), el porcentaje de grasa corporal (PGC), así como los diámetros y circunferencias de los atletas: una vez al comienzo de la temporada y otra seis meses después. Como resultado, se encontró que incluso los atletas de élite experimentan cambios en su composición corporal durante los períodos de entrenamiento intenso para competiciones de alto nivel.

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INTRODUCTION

Morphological characteristics are considered fundamental determinants of athletic performance and physical capacity. In sports science and training, analyzing athletes' body structures has proven to be a valuable approach in evaluating the physiological demands and physical adaptations associated with different sports disciplines (Malacko et al., 2015).

Body composition assessment plays a critical role in monitoring both performance and the effectiveness of training programs. This is especially relevant in sports where body mass directly impacts performance—such as in jumping and climbing disciplines—as well as in weight-class sports and aesthetic-based events, where physical appearance and tissue composition strongly influence outcomes (Ackland et al., 2012). Research has shown that sport-specific training programs lead to not only improvements in motor skills but also significant changes in body structure (Madic et al., 2018; Buśko et al., 2017).

Elite athletes are often perceived as representations of physical excellence, and their anthropometric profiles are frequently regarded as performance models within their disciplines (Drinkwater et al., 2005; Sundgot-Borgen and Torstveit, 2010). Accordingly, investigating the physical characteristics and body composition of such athletes offers valuable insights into the specific requirements and performance standards of each sport. Morphological traits—which reflect an athlete's body dimensions, proportions, and composition—are closely related to physiological potential and high-level performance (Maud and Foster, 1995).

In weight-class sports such as wrestling and judo, maintaining a specific body weight before competition is essential. Athletes competing in these sports often follow strict dietary and body weight regulation strategies, particularly as they approach competition dates, in order to reach the required body fat percentage and match weight class standards (Drinkwater et al., 2005; Slater et al., 2005; Sundgot-Borgen and Garthe, 2011; Yoon, 2002). These strategies can result in notable fluctuations in body fat ratio and overall body composition within the same competition season.

Although seasonal changes in body composition have been reported in different athletic populations (Rodrigues-Ferreira et al., 2015; Madic et al., 2018), evidence regarding longitudinal body composition changes in elite national team athletes from different Olympic sports remains limited. Since wrestling, judo, and athletics differ considerably in their physiological characteristics and sport-specific training demands (Malacko et al., 2015; García-Pallarés et al., 2011), discipline-specific patterns of anthropometric adaptation may be expected. Combat sports such as wrestling and judo generally emphasize muscular strength, power development, and body weight regulation (Yoon, 2002; Slater et al., 2005; Sundgot-Borgen and Garthe, 2011), whereas athletics disciplines generally emphasize the development of speed, endurance, and running economy (Saunders et al., 2004; Barnes and Kilding, 2015). Consequently, the magnitude and direction of changes in body weight, body fat percentage, and regional anthropometric measurements may differ according to the specific training characteristics of each sport.

Accordingly, this study aimed to examine changes in body composition among athletes from four sports disciplines in the Kyrgyz National Team (Greco-Roman wrestling, freestyle wrestling, judo, and athletics) during a six-month preparatory training period. It was hypothesized that significant changes would occur in body composition variables throughout the training period and that the magnitude of these changes would differ among disciplines due to their distinct physiological and motor demands.

MATERIAL AND METHODS

SUBJECTS

35 Kyrgyzstan National Team athletes from 4 different sport branches, who were recommended by Kyrgyzstan Ministry of Sports Olympic Games Committee, have been included in this research (Table1). The measurements of the athletes have been taken two times in total as six months intervals. The study protocol was approved by the ethics committee of Kyrgyzstan State Sports Academy (no 115).

TRAINING PERIOD AND MEASUREMENT TIMING

To provide a clearer description of the training process, the six-month preparation period was divided into four phases: Adaptation and General Preparation (8 weeks), Specific Preparation I (6 weeks), Specific Preparation II (6 weeks), and Competition Period (4

Table 1. The characteristics of athletes.

Discipline	n	Age (Years) Mean ± SD	Height (cm) Mean ± SD
Greco-Roman Wrestlers	9	24.00±4.50	169.60±9.44
Freestyle Wrestlers	10	22.10±3.21	164.31±4.75
Judo	8	23.60±1.89	175.7±36.87
Athletics	8	22.29±2.87	177.88±6.31

weeks). For wrestlers and judo athletes, the Adaptation and General Preparation phase primarily focused on strength development (70%) and technical-tactical training (30%). During Specific Preparation I, technical-tactical training (50%) and strength development (50%) were emphasized equally. In Specific Preparation II, training focused on technical-tactical development (50%) and explosive strength and speed development (50%). During the Competition Period, training emphasized technical-tactical preparation (50%), match simulation exercises (30%), and the maintenance of explosive strength and speed (20%).

For athletics athletes, the Adaptation and General Preparation phase focused primarily on general physical preparation (70%) and technical training (30%). During Specific Preparation I, event-specific technical training (50%) and general physical preparation (50%) were emphasized. Specific Preparation II focused on event-specific performance development (60%) and speed/endurance training (40%). During the Competition Period, training emphasized event-specific technical preparation (50%), competition simulation exercises (30%), and performance maintenance (20%). The percentages presented represent the approximate distribution of training content throughout the preparation phases and were derived from the annual training plans implemented by the respective national team coaching staffs.

Across all disciplines, training intensity was deliberately reduced to 50% of normal volume one week prior to development tournaments. This tapering strategy aimed to optimize both physiological readiness and psychological focus before competition.

MEASUREMENT PROCEDURES

A scale sensitive to 20 grams was used for body weight measurements. Height measurements were obtained using a Holtain anthropometer. Body Mass Index (BMI) was calculated as body weight (kg) divided by height squared (m^2). Athletes' body circumference measurements were performed using an anthropometric tape measure (Gulick Meter) with an accuracy of ±1 mm. Diameter measurements were performed using an anthropometric sliding caliper (Holtain, UK) with an accuracy of ±1 mm. Body fat measurements were made using a 0.2 mm skinfold caliper (Holtain, Crymych, UK). Body fat percentage was calculated using the Siri (1956) method. The same experienced investigator following standardized anthropometric protocols performed all anthropometric measurements. The same equipment and measurement procedures were used throughout the study to minimize inter-observer variability and measurement error.

STATISTICAL ANALYSIS

Statistical analyses were performed using SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). A mixed-design ANOVA was conducted with Time (pre-test vs. post-test) as the within-subject factor and Discipline (Greco-Roman wrestling, freestyle wrestling, judo, and athletics) as the between-subject factor. Main effects of Time, Discipline, and Time × Discipline interactions were examined for all body composition and anthropometric variables. Partial eta-squared (ηp^2) values were calculated to estimate effect sizes. Statistical significance was accepted at $p < 0.05$.

RESULTS

Table 1 presents the average age and height of the Kyrgyz National Team athletes from four different sports disciplines included in the study. Table 2 presents the results of the mixed-design ANOVA for body weight, BMI, and body fat percentage. Significant Time × Discipline

Table 2. Morphological changes in participants over the 6-month preparatory training period.

Discipline		Pre-test Mean ± SD	Post-test (after 6 months) Mean ± SD	Time				Discipline			Time × Discipline		
				Δ	F	p	η^2	F	p	η^2	F	p	η^2
Weight (kg)	Greco-Roman	72.02 ± 7.07	73.08 ± 6.34	+1.06	2.727	.109	.081	8.460	< .001	.450	12.373	< .001	.545
	Freestyle	64.75 ± 6.20	66.68 ± 5.90	+1.93									
	Athletics	64.98 ± 5.93	64.45 ± 5.96	−0.53									
	Judo	86.20 ± 16.55	85.08 ± 16.34	−1.13									
BMI (kg/m^2)	Greco-Roman	25.05 ± 2.45	25.42 ± 2.28	+0.38	0.195	.662	.006	9.206	< .001	.471	5.312	.005	.340
	Freestyle	23.94 ± 1.44	24.36 ± 1.56	+0.43									
	Athletics	20.49 ± 0.71	20.32 ± 0.75	-0.17									
	Judo	27.87 ± 4.65	27.01 ± 5.17	-0.86									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

Table 2. Continued...

Discipline		Pre-test Mean ± SD	Post-test (after 6 months) Mean ± SD	Time				Discipline			Time × Discipline		
				Δ	F	p	η^2	F	p	η^2	F	p	η^2
Bodyfat (%)	Greco-Roman	10.07 ± 3.32	9.98 ± 3.28	-0.09	0.178	.676	.006	0.906	.449	.081	0.017	.997	.002
	Freestyle	10.94 ± 6.86	10.65 ± 6.04	-0.28									
	Athletics	9.11 ± 0.93	9.03 ± 0.94	-0.07									
	Judo	13.19 ± 7.50	12.95 ± 7.20	-0.24									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

interactions were observed for body weight (F = 12.373, p < .001, ηp^2 = .545) and BMI (F = 5.312, p = .005, ηp^2 = .340), indicating that the magnitude and direction of changes during the six-month training period differed among disciplines. Specifically, body weight and BMI increased in Greco-Roman and freestyle wrestlers, whereas decreases were observed in judo and athletics athletes. In contrast, no significant Time × Discipline interaction was found for body fat percentage (F = 0.017, p = .997, ηp^2 = .002), suggesting that changes in body fat percentage were similar across disciplines.

As shown in Table 3, mixed-design ANOVA revealed significant main effects of time for shoulder, neck, biceps, chest, abdomen, hip, and femur circumferences (p < .05), whereas no significant time effects were observed for lower leg, wrist, or ankle circumferences (p > .05). Significant main effects of discipline were identified for all variables except abdomen and ankle circumferences, indicating anthropometric differences among sports disciplines. Furthermore, significant Time × Discipline interactions were detected for shoulder (F = 5.910, p = .003, ηp^2 = .364), neck (F = 5.565, p = .004, ηp^2 = .350), biceps (F = 21.614, p < .001, ηp^2 = .677), abdomen (F = 4.384, p = .011, ηp^2 = .298), and femur circumferences (F = 7.099, p = .001, ηp^2 = .407). These findings indicate that changes in these circumference measurements during the six-month training period differed according to sport discipline. In contrast, no significant Time × Discipline interactions were observed for chest, hip, lower leg, wrist, or ankle circumferences (p > .05).

As shown in Table 4, mixed-design ANOVA revealed a significant main effect of time only for thigh diameter (F = 150.376, p < .001, ηp^2 = .829), indicating an overall increase from pre-test to post-test. Significant main effects of discipline were observed for humerus diameter (F = 10.328, p < .001, ηp^2 = .500) and elbow diameter (F = 5.200, p = .005, ηp^2 = .335), whereas shoulder, chest, and thigh diameters did not differ significantly among disciplines (p > .05). A significant Time × Discipline interaction was identified for thigh diameter (F = 3.938, p = .017, ηp^2 = .276), suggesting that changes over time varied according to discipline. No significant interaction effects were observed for shoulder, chest, humerus, or elbow diameters (p > .05).

Furthermore, wrist diameter, ankle diameter, and foot-ankle diameter showed neither significant time effects nor significant Time × Discipline interactions (p > .05). In contrast, chest depth demonstrated a significant increase over time (F = 12.287, p = .001, ηp^2 = .284). Significant main effects of discipline were also observed for wrist diameter (F = 5.397, p = .004, ηp^2 = .343), ankle diameter (F = 3.095, p = .041, ηp^2 = .230), and chest depth (F = 3.037, p = .044, ηp^2 = .227), indicating anthropometric differences among disciplines. Moreover, a significant Time × Discipline interaction was found for chest depth (F = 3.759, p = .021, ηp^2 = .267), suggesting discipline-specific adaptations during the six-month training period.

DISCUSSION

This study aimed to investigate changes in body composition among athletes from four disciplines in the Kyrgyz National Team (Greco-Roman wrestling, freestyle wrestling, judo, and athletics) during a six-month preparatory period, as they pursued qualification opportunities for high-level competitions such as the Olympic Games. It is widely recognized that elite athletes, particularly those aiming for prestigious international events, dedicate nearly the entire year to intensive and structured training programs. At this level, their anthropometric and physical characteristics are typically well established, and therefore, major changes are generally not expected. However, the desire to qualify for events such as the Olympics represents the pinnacle of athletic ambition, motivating these athletes to push the limits of their physical and psychological capacities. Accordingly, this study sought to examine changes in body composition, somatotype profiles, and anthropometric measurements during this critical training period. The underlying hypothesis was that significant changes would occur in body composition variables throughout the six-month training period and that the magnitude of these changes would differ among sport disciplines because of their distinct physiological and motor demands.

Table 3. Athletes' body region circumference changes during the preparatory training period.

Variable (cm)	Discipline	Pre-test (Mean ± SD)	Post-test (after 6 months) (Mean ± SD)	Δ	Time			Discipline			Time × Discipline		
					F	p	η^2	F	p	η^2	F	p	η^2
Shoulder	Greco-Roman	113.23 ± 6.46	113.30 ± 6.47	+0.07	42.422	<.001	.578	6.058	.002	.370	5.910	.003	.364
	Freestyle	111.22 ± 7.69	111.37 ± 7.65	+0.15									
	Athletics	105.96 ± 4.55	106.05 ± 4.49	+0.09									
	Judo	122.56 ± 11.91	122.90 ± 12.01	+0.34									
Neck	Greco-Roman	40.48 ± 1.72	40.59 ± 1.74	+0.11	20.838	<.001	.402	12.113	<.001	.540	5.565	.004	.350
	Freestyle	39.53 ± 2.20	39.61 ± 2.20	+0.08									
	Athletics	36.21 ± 1.48	36.18 ± 1.46	-0.04									
	Judo	42.60 ± 3.09	42.76 ± 3.11	+0.16									
Biceps	Greco-Roman	33.17 ± 2.23	34.11 ± 2.25	+0.94	150.027	<.001	.829	14.494	<.001	.584	21.614	<.001	.677
	Freestyle	31.03 ± 2.52	31.73 ± 2.56	+0.70									
	Athletics	28.18 ± 1.70	28.21 ± 1.72	+0.04									
	Judo	35.95 ± 3.43	36.33 ± 3.31	+0.38									
Chest	Greco-Roman	99.72 ± 7.91	99.88 ± 7.84	+0.16	24.074	<.001	.437	5.308	.005	.339	1.261	.305	.109
	Freestyle	96.27 ± 8.53	96.39 ± 8.54	+0.12									
	Athletics	87.33 ± 4.16	87.36 ± 4.14	+0.04									
	Judo	105.54 ± 14.49	105.65 ± 14.50	+0.11									
Abdomen	Greco-Roman	80.96 ± 8.08	80.90 ± 8.06	-0.06	21.131	<.001	.405	2.545	.074	.198	4.384	.011	.298
	Freestyle	79.47 ± 8.61	79.36 ± 8.64	-0.11									
	Athletics	71.95 ± 3.18	71.86 ± 3.18	-0.09									
	Judo	85.64 ± 16.29	85.26 ± 16.10	-0.38									
Hip	Greco-Roman	96.16 ± 5.44	96.31 ± 5.38	+0.16	14.741	.001	.322	4.105	.015	.284	2.849	.053	.216
	Freestyle	93.52 ± 6.82	93.61 ± 6.80	+0.09									
	Athletics	88.59 ± 5.33	88.56 ± 5.34	-0.03									
	Judo	100.68 ± 10.17	100.83 ± 10.22	+0.15									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

Table 3. Continued...

Variable (cm)	Discipline	Pre-test (Mean ± SD)	Post-test (after 6 months) (Mean ± SD)	Δ	Time			Discipline			Time × Discipline		
					F	p	η^2	F	p	η^2	F	p	η^2
Femur	Greco-Roman	56.27 ± 4.40	56.60 ± 4.44	+0.33	64.451	<.001	.675	5.640	.003	.353	7.099	.001	.407
	Freestyle	52.81 ± 4.53	53.12 ± 4.57	+0.31									
	Athletics	49.69 ± 3.97	49.70 ± 4.05	+0.01									
	Judo	59.74 ± 7.60	59.95 ± 7.62	+0.21									
Lower Leg	Greco-Roman	37.87 ± 2.79	37.89 ± 2.91	+0.02	2.930	.097	.086	4.225	.013	.290	0.384	.765	.036
	Freestyle	34.72 ± 2.63	34.82 ± 2.57	+0.10									
	Athletics	34.35 ± 1.93	34.41 ± 1.88	+0.06									
	Judo	38.31 ± 3.98	38.34 ± 4.07	+0.03									
Wrist	Greco-Roman	18.43 ± 0.80	18.47 ± 0.82	+0.03	2.532	.122	.076	22.651	<.001	.687	0.122	.946	.012
	Freestyle	17.12 ± 0.71	17.14 ± 0.77	+0.02									
	Athletics	15.43 ± 0.88	15.46 ± 0.90	+0.04									
	Judo	18.46 ± 1.04	18.48 ± 1.00	+0.01									
Ankle	Greco-Roman	22.63 ± 1.13	22.62 ± 1.12	-0.01	0.124	.727	.004	2.782	.057	.212	0.425	.737	.039
	Freestyle	21.46 ± 1.34	21.48 ± 1.37	+0.02									
	Athletics	21.01 ± 1.15	21.00 ± 1.11	-0.01									
	Judo	22.56 ± 1.96	22.59 ± 1.93	+0.03									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

Table 4. Athletes' seasonal changes in diameter measurements.

Variable	Discipline	Pre-test (Mean ± SD)	Post-test (after 6 months) (Mean ± SD)	Δ	Time			Discipline					
					F	p	η^2	F	p	η^2	F	p	η^2
Shoulder Diameter (cm)	Greco-Roman	40.12 ± 1.90	40.14 ± 1.83	+0.02	1.638	.210	.050	1.185	.332	.103	0.501	.685	.046
	Freestyle	39.56 ± 2.01	39.61 ± 2.03	+0.05									
	Athletics	39.80 ± 1.63	39.79 ± 1.57	-0.01									
	Judo	41.31 ± 2.73	41.35 ± 2.70	+0.04									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

Table 4. Continued...

Variable	Discipline	Pre-test (Mean ± SD)	Post-test (after 6 months) (Mean ± SD)	Δ	Time			Discipline			Time × Discipline		
					F	p	η^2	F	p	η^2	F	p	η^2
Chest Diameter (cm)	Greco-Roman	30.76 ± 2.47	30.77 ± 2.45	+0.01	2.216	.147	.067	1.836	.161	.151	0.929	.438	.083
	Freestyle	30.50 ± 2.68	30.49 ± 2.64	-0.01									
	Athletics	28.29 ± 1.57	28.33 ± 1.51	+0.04									
	Judo	31.20 ± 3.81	31.28 ± 3.82	+0.08									
Thigh Diameter (cm)	Greco-Roman	28.46 ± 1.92	28.81 ± 2.00	+0.36	150.376	<.001	.829	0.864	.470	.077	3.938	.017	.276
	Freestyle	27.80 ± 1.99	28.12 ± 2.00	+0.32									
	Athletics	27.83 ± 1.14	28.08 ± 1.16	+0.25									
	Judo	29.14 ± 3.14	29.68 ± 3.10	+0.54									
Humerus Diameter (cm)	Greco-Roman	8.03 ± 0.82	8.06 ± 0.82	+0.02	1.161	.290	.036	10.328	<.001	.500	0.406	.750	.038
	Freestyle	8.00 ± 1.20	8.04 ± 1.21	+0.04									
	Athletics	6.70 ± 0.75	6.69 ± 0.74	-0.01									
	Judo	9.50 ± 1.17	9.53 ± 1.17	+0.03									
Elbow Diameter (cm)	Greco-Roman	6.67 ± 0.58	6.69 ± 0.61	+0.02	1.802	.189	.055	5.200	.005	.335	0.048	.986	.005
	Freestyle	7.06 ± 0.38	7.09 ± 0.43	+0.03									
	Athletics	6.29 ± 0.37	6.31 ± 0.33	+0.03									
	Judo	7.18 ± 0.64	7.19 ± 0.65	+0.01									
Wrist Diameter (cm)	Greco-Roman	5.43 ± 0.25	5.43 ± 0.28	0.00	0.098	.756	.003	5.397	.004	.343	0.202	.894	.019
	Freestyle	5.34 ± 0.20	5.32 ± 0.20	-0.02									
	Athletics	5.11 ± 0.22	5.10 ± 0.15	-0.01									
	Judo	5.49 ± 0.18	5.50 ± 0.20	+0.01									
Ankle Diameter (cm)	Greco-Roman	9.56 ± 0.46	9.53 ± 0.52	-0.02	0.000	.997	.000	3.095	.041	.230	0.253	.859	.024
	Freestyle	9.43 ± 0.64	9.44 ± 0.65	+0.01									
	Athletics	9.44 ± 0.77	9.44 ± 0.81	0.00									
	Judo	10.30 ± 0.78	10.31 ± 0.84	+0.01									
Foot-Ankle Diameter (cm)	Greco-Roman	6.97 ± 0.55	6.98 ± 0.56	+0.01	0.125	.726	.004	2.417	.085	.190	0.518	.673	.048
	Freestyle	6.94 ± 0.68	6.94 ± 0.68	0.00									
	Athletics	7.29 ± 0.45	7.30 ± 0.47	+0.01									
	Judo	7.58 ± 0.49	7.56 ± 0.48	-0.01									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

Table 4. Continued...

Variable	Discipline	Pre-test (Mean ± SD)	Post-test (after 6 months) (Mean ± SD)	Δ	Time			Discipline					
					F	p	η^2	F	p	η^2	F	p	η^2
Chest Depth (cm)	Greco-Roman	19.74 ± 2.11	19.77 ± 2.09	+0.02	12.287	.001	.284	3.037	.044	.227	3.759	.021	.267
	Freestyle	18.61 ± 2.21	18.61 ± 2.21	0.00									
	Athletics	17.80 ± 1.21	17.89 ± 1.25	+0.09									
	Judo	21.55 ± 4.32	21.58 ± 4.25	+0.03									

Mixed-design ANOVA was used for statistical analysis. Time = pre-test vs. post-test; Discipline = sport discipline; Time × Discipline = interaction effect; ηp^2 = partial eta squared; Δ = absolute change from pre-test to post-test (Post-test − Pre-test).

Recent research has increasingly focused on the anthropometric characteristics of elite athletes (Malacko et al., 2015; Rodrigues-Ferreira et al., 2015; Luciana Z., 2012; Silva et al., 2010; Eksterowicz et al., 2016). It is well established that an individual's inherent somatic structure plays a critical role in their suitability for specific sports, while regular, sport-specific training contributes to observable changes in body composition (Gualdi-Russo and Zaccagni, 2001). Accordingly, changes in circumference measurements are to be expected even in highly trained athletes.

As shown in Table 2, significant Time × Discipline interactions were observed for body weight and BMI ($p < 0.05$), indicating that the magnitude and direction of changes differed among sports disciplines during the six-month training period. These findings support the study hypothesis that anthropometric adaptations would vary according to the physiological and motor demands of different sports. In this study, body weight and BMI increased in Greco-Roman and freestyle wrestlers during the six-month training period, whereas decreases were observed in judo and athletics athletes. These contrasting responses likely reflect differences in training objectives, body weight management strategies, and sport-specific performance requirements. The discipline-specific differences observed in the present study are likely related to the distinct physiological and motor demands of each sport. Wrestling and judo require repeated high-intensity efforts, substantial muscular strength, explosive power production, and, in many cases, strict body weight regulation before competition (Yoon, 2002; Slater et al., 2005; Sundgot-Borgen and Garthe, 2011). Consequently, changes in body weight, BMI, and regional anthropometric measurements may reflect adaptations associated with strength-oriented training and muscular hypertrophy. In contrast, athletics athletes, particularly middle-distance runners, generally emphasize movement economy, aerobic efficiency, and an optimal power-to-weight ratio, factors that may contribute to reductions in body weight and BMI during prolonged preparation periods (Ackland et al., 2012). These sport-specific demands provide a plausible explanation for the significant Time × Discipline interactions observed in the present study. These findings are consistent with existing literature reporting similar outcomes following intensive training cycles (Silva et al., 2010).

As presented in Table 3, significant Time × Discipline interactions were identified for neck, shoulder, biceps, abdomen, and femur circumferences ($p < 0.05$), demonstrating discipline-specific patterns of morphological adaptation. These findings further support the hypothesis that different training stimuli lead to distinct anthropometric responses in elite athletes. Furthermore, significant increases were observed in biceps, chest, hip, and femoral circumferences in athletes from the Greco-Roman wrestling, freestyle wrestling, and judo groups ($p < 0.05$). Additionally, neck circumference increased in Greco-Roman wrestling and judo athletes, while waist circumference decreased significantly across all three groups ($p < 0.05$). These increases in muscle girths are likely attributable to the impact of structured strength training and the physical demands of Olympic-level preparation. Although the athletes already competed at an elite level, the intensity and specificity of their training programs appear to have prompted additional morphological adaptations. In contrast, chest and hip circumferences did not demonstrate significant Time × Discipline interaction effects ($p > 0.05$), suggesting that some anthropometric adaptations may occur similarly across disciplines despite differences in training content. These findings are supported by previous studies (García-Pallarés et al., 2011; Withers et al., 1987; Pollock et al., 1977; Santos et al., 2014).

Changes in body composition during this period also support earlier findings highlighting the decisive influence of high-intensity, long-duration training on physiological outcomes (Galliven et al., 1997; Toth et al., 1999; Wilmore et al., 1999; Kannin and Phil, 2005). Although the decrease in waist circumference was not always statistically significant, it likely reflects reductions in body fat percentage. This aligns with well-established evidence showing that athletes with lower body fat levels tend to achieve better performance outcomes in certain competitive sports (Reilly, 1996; Ostojic and Zivanic,

2001). During prolonged high-intensity training, fat stores are mobilized and oxidized for energy, particularly when training intensity reaches approximately 85% of VO_2max (Wolfe, 1998; Smith et al., 2000).

As shown in Table 4, significant Time × Discipline interactions were observed for thigh diameter and chest depth ($p < 0.05$), whereas most diameter measurements did not demonstrate significant interaction effects ($p > 0.05$). These findings indicate that certain skeletal and structural dimensions remain relatively stable even during intensive training periods, while others continue to adapt in a discipline-specific manner. Previous studies have reported that bone breadths and skeletal dimensions are largely determined by genetic and constitutional factors and therefore show limited responsiveness to short- and medium-term training interventions, particularly in adult elite athletes (Maud and Foster, 1995). In contrast, measurements influenced by muscular hypertrophy and regional morphological adaptations may exhibit greater sensitivity to sport-specific training loads. This partially explains why the study hypothesis was supported for some, but not all, anthropometric variables.

Moreover, the present study is noteworthy because it simultaneously examined elite national team athletes from multiple Olympic sports disciplines undergoing the same Olympic qualification preparation period. This approach provided a unique opportunity to compare discipline-specific adaptations under comparable training and competitive conditions and contributes valuable longitudinal data to the limited literature on elite Olympic-level athletes.

The present study has several limitations that should be considered when interpreting the findings. First, although the athletes included in the study were members of the Kyrgyz National Team and were preparing for Olympic qualification competitions, no subsequent competition performance data were available. Therefore, direct relationships between the observed anthropometric changes and competitive success could not be established. Second, all anthropometric measurements were performed by the same experienced investigator using standardized procedures; however, formal test–retest and inter-observer reliability analyses were not conducted. Finally, the sample size within some disciplines was relatively limited due to the restricted number of elite national team athletes available for inclusion. Future studies incorporating larger samples and performance-related outcomes may provide a more comprehensive understanding of sport-specific adaptations during Olympic preparation periods.

In conclusion, the present findings largely support the study hypothesis and demonstrate that anthropometric adaptations during a six-month preparatory training period are not uniform across sports disciplines. Significant Time × Discipline interactions observed in several body composition and anthropometric variables indicate that sport-specific training demands influence the magnitude and direction of morphological adaptations. These findings provide valuable information for monitoring elite athletes during critical preparation periods and may contribute to the optimization of sport-specific training programs.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest in publishing the results of this investigation.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AUTHORS' CONTRIBUTION

BD: Conceptualization, methodology, data analysis, writing – original draft, and writing – review and editing. KC: Conceptualization, methodology, and supervision. DA: Data collection, investigation, and methodology. SG: Data analysis, interpretation of results, and writing – review and editing. RG: Data collection, literature review, and writing – review and editing. All authors read and approved the final version of the manuscript.

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